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LCA as a means to assess land use implication of new production priorities

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3rd LaSyS Workshop

Land system science – Handling complex series of natural and socio-economic processes

25 - 26 October 2007

Tune Kursuscenter, Greve, Denmark

Organizer

Danish Network for Land System Science (LaSyS)

3rd LaSyS Workshop

Land system science - Handling complex series of natural and socio-economic processes

25 – 26 October 2007

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Third LaSyS Workshop - Programme

Land system science - Handling complex series of natural and socio-economic processes

Venue: Tune Kursuscenter
Date: October 25-26th 2007

This third LaSyS-workshop is evolving around three main themes. The first captures some of the main contemporary lines of thought in the international land system science community. The second addresses the issue of interdisciplinary approaches to land systems research, specifically how different cultures, agendas, success criteria, mutual interactions and meaning create (insurmountable?) challenges for land system science researchers. The third addresses how the role, importance and character of 'decision making' as a pivotal parameter in land system dynamics have changed.

Programme

Day 1: Thursday, October 25th

9:00-9:30 *Registration and coffee/tea*

9:30-9:45 **Opening address** (chair: Anette Reenberg)

Theme 1: Contemporary approaches to land systems science

Speakers in this session present – based on their broad experience – recent developments within land systems science and identify visions and future challenges for the land systems research community (chair: Bent Odgaard and Per Christensen)

9:45-10:15 **Sandra Lavorel** (Functional approaches to quantifying the response to land use change of multiple ecosystem service delivery. Université Joseph Fourier, France)

10:15-10:45 **Marie-José Gaillard** (Novel approaches to long-term reconstruction of past landscapes and land use as an aid to present and future landscape management. Kalmar University, Sweden)

10:45-11:00 **Discussion**

11:00-11:15 *Coffee/Tea Break*

11:15-11:45 **Karlheinz Erb** (Global human appropriation of net primary production: Population, affluence, technology, trade - and biodiversity. University of Klagenfurt, Austria)

11:45-12:15 **Tom Veldkamp** (Advances in Land Models. Wageningen University, The Netherlands)

12:15-12:45 **Ruth DeFries** (What the Bird's Eye View Does and Does Not Reveal about Land Systems. University of Maryland, College Park, USA)

12:45-13:00 **Discussion**

13:00-14:00 *Lunch break*

Theme 2: Interdisciplinarity in land systems science: different cultures, agendas, success criteria, mutual interactions and meanings

The presentations in this session places emphasis on challenges related to interdisciplinary land systems research. The presenters discuss - using examples from their individual disciplinary background – what they will require in terms of level of documentation and standards to confirm research hypothesis. The panel discussion focus on how to deal with the different disciplinary cultures, agendas, data standards, empirical demands and meanings (chair: Anette Reenberg)

14:00-14:20 **Finn Arler** (Interdisciplinarity - Why it is so difficult and yet so rewarding… Aalborg University, Denmark)

14:20-14:40 **Kjeld Rasmussen** (Land system science: Crossing the boundaries between the natural and social sciences. University of Copenhagen, Denmark)

14:40-15:00 **Lowe Börjeson** (Land systems science and history. Stockholm University, Sweden, University of Dar es Salaam, Tanzania)

15:00-15:15 *Coffee/Tea break*

15:20-15:40 **Eric Lambin** (Land change and infectious diseases: the emerging discipline of spatial epidemiology. Université de Louvain, Belgium)

15:40-16:00 **Jakob Magid et al.** (Thinking outside the box … – 10 years of practical experiences in interdisciplinary education and research. University of Copenhagen, Denmark)

16:00-17:00 **Panel discussion** (all speakers from the afternoon session)

Key questions
- *What make sense to different sciences and different stakeholders?*
- *Puzzle solving or problem solving?*

17:00-17:30 **Short oral presentation of posters** (chair: Jakob Magid)

18:00-19:30 *Dinner*

19:30- **Poster viewing**

Day 2: Friday, October 26th

Theme 3: Strategic management goals and valuation of landscapes

(chair: Jørgen E. Olesen and Finn Arler)

9:00-9:30 **Frank Ewert** (Managing land use in Europe under changing climate and market conditions. Wageningen University, The Netherlands)

9:30-10:00 **Vivian Kvist Johannsen** (Management and forests in landscapes - the biofuel production case. University of Copenhagen, Denmark)

10:00-10:15 **Discussion**

10:15-10:30 *Coffee/Tea Break*

10:30-11:00 **Jannick Schmidt** (LCA as a means to assess land use implication of new production priorities. Aalborg University, Denmark)

11:00-11:30 **Ole Hjort Caspersen** (Effective Governance for Sustainability - Landscape Character Assessment at the Municipality level in Denmark. University of Copenhagen, Copenhagen, Denmark)

11:30-12:00 **Jesper Fredshavn** (Indicators and methods to assess biological qualities. Danish Environmental Research Institute, Denmark)

12:00-12:15 **Discussion**

12:15-13:15 *Lunch break*

13:15-13:45 **Danish Land Systems Science – today and in the future?** (chair: Kjeld Rasmussen)

13:45-15:00 **Discussion groups: future research collaboration**

15:00-15:15 **Concluding remarks by the organising committee** (chair: John R. Porter)

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Interdisciplinarity - Why it is so difficult and yet so rewarding…

By Finn Arler

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Abstract
"Double the pain, half the gain" is a slogan often related to interdisciplinarity. It is difficult, and usually not recognized and rewarded by the scientific community, at least not as much as singledisciplinarity, and certainly not as much as it deserves. On the other hand, most people involved in interdisciplinary studies find this kind of cooperation very attractive. In the presentation I shall try to identify the main difficulties and barriers involved in interdisciplinary studies. I shall focus, in particular, on problems related to organisational structures, ideals and ambitions, limitations on mutual understanding, incompatible ideals of integration, the role of normativity, as well as concepts of causality and explanation. Given these difficulties, the fact that many people are attracted to interdisciplinary studies is astonishing. I shall try to find some explanation.

Management and forests in landscapes - the biofuel production case

By Vivian Kvist Johannsen

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Abstract
Denmark would naturally be covered with forest if it was not for management goals. The development from the very first forests until the forests today is described with forests as the indicator of the management goals for the landscapes in general. New management goals emerge. Amongst these are need for provision of ecosystem services and products. As case the need for biofuel is highlighted illustrating the potential impact of biofuel production on the forested landscapes of Denmark and how forests can be valuated in the landscapes.

Managing land use in Europe under changing climate and market conditions

By Frank Ewert

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Abstract
Land use evolves in response to changes in nature and society. Conversely, changes in land use affect a number of services provided by nature to human society such as the supply of food and water, biodiversity, landscape quality and recreation. Understanding the factors and relationships determining land use change and associated impacts is vital for a sustainable use and management of land.

Despite considerable progress in recent years estimation of changes in land use and associated impacts on ecosystems' functioning and service provision to society remains difficult. Particularly challenging is the quantification of the complex interactions between bio-physical and socio-economic drivers that often relate to different scales and require adequate scaling approaches. The dynamic character of land use change including feedback loops is difficult to consider particularly for factors representing changes in society. Attempts to assess and evaluate land use change impacts across different ecosystem services are scarce. Economically based methods of valuing ecosystem services are available but have clear limitations for long term assessments and strategic planning.

The presentation reviews recent efforts in projecting future land use change for Europe and associated impacts on different ecosystem services. Specific emphasis is on agricultural land use and projected responses to combined changes in climate and market conditions. Associated impacts of land use changes are presented for farmer livelihood, carbon sequestration and biodiversity. Attempts to evaluate and compare impacts of land use change on different ecosystem services are discussed. Integrated assessment and modelling is proposed as a way to support management and policy making towards a sustainable use of land. The process of management and decision making is viewed within the context of complex systems and its relation to scale.

Global human appropriation of net primary production: Population, affluence, technology, trade - and biodiversity

By Haberl, H., K.-H. Erb, F. Krausmann, M. Wiesinger, V. Gaube, S. Gingrich

Presenter: Karlheinz Erb, Klagenfurt University, Institute of Social Ecology, Vienna, Austria
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Abstract
Human land use currently reduces the amount of NPP remaining in the earth's terrestrial ecosystems as energy input for all heterotrophic food chains by about 25%. By combining a spatially explicit (5 min geographic resolution) global database of the global human appropriation of net primary production (HANPP) with a national-level biomass flow database for c140 countries (c97% of world population) we have established maps that trace HANPP from the place of harvest to the place of consumption. We show that biomass demand in populated areas results in considerable drains on ecosystem services in producing regions, a process that has reached global proportions. International biomass trade was responsible for 21% of global HANPP in 2000. We find that biomass flows from sparsely to densely populated areas, not from poor to rich countries. The presentation will use this dataset to analyze drivers of HANPP, including population (density), affluence, technology and trade, and discuss possible impacts on biodiversity.

LCA as a means to assess land use implication of new production priorities

By Jannick H. Schmidt

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Abstract
The demand for agricultural products and especially biofuels is on the rise. The land-use required for meeting this increasing demand has significant impacts. New methodological developments within life cycle assessment (LCA) make it possible to assess the impact on land-use and biodiversity from increased agricultural production. Rapeseed oil and palm oil are the most used vegetable oils for biodiesel. Normally, the attitude towards palm oil is that it has undesirable effects on tropical forests while the impacts of rapeseed oil from the EU are less significant. Here, the land-use effects from the two oils are discussed in the framework of LCA, i.e. the oils are compared against a common reference (functional unit), the product systems of the two oils are defined as all affected processes in order to deliver the functional unit, and the land-use interventions (occupation and transformation of land) are compiled into land-use impacts (biodiversity). When assessing agricultural production, it is important to take into account; 1) that increasing the cultivation of one crop in one region may affect the cultivated area in other parts of the world, 2) what type of land is transformed into agricultural production, and 3) when the product of interest is co-produced with a co-product, it must be taken into account that the production of the alternative product to the co-product is avoided. Applying these three features to the product systems of rapeseed oil and palm oil shows that the land-use effects from the two oils are globally distributed.

Generally, production of one tonne of palm oil requires less land than one tonne of rapeseed oil. The required land for production of rapeseed oil is highly dependant on whether increased cultivation takes place at the expanse of other crops (barley) or by cultivating set-aside areas. Cultivation of rapeseed at the expanse of other crops requires more land because high yielding barley in the EU is substituted by low yielding barley in Canada. Compiling the land-use interventions to land-use impacts (biodiversity), the differences between rapeseed oil and palm oil is less pronounced. The reason why palm oil does not have a significant higher impact than rapeseed oil is because it requires less land, and because the remaining ecosystems in the EU are more sensitive to further pressures compared to Malaysia and Indonesia which still have large areas covered with natural vegetation. The impacts from transformation of land for rapeseed and oil palm cultivation also show great differences.

Transformation of scrub land/grassland into oil palm has even negative impacts because oil palm plantations support more species than scrub land/grassland. The ranking of rapeseed oil and palm oil is completely dependant on the way increased cultivation is achieved; Rapeseed: at the expense of other crops or cultivation of set-aside areas, Oil palm: transformation of secondary/degraded forest or scrub land/grassland. The use of the LCA framework for assessing land-use impacts has shown to be a comprehensive approach which can incorporate hidden impacts (when exporting the impacts) and the differences between different ways of increasing cultivation.

Indicators and methods to assess biological quality

By Jesper Fredshavn

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Abstract
A new assessment system for evaluating the biological quality of terrestrial nature types has been developed in Denmark. The system is developed to assess biological quality based on measurable and objective indicators to evaluate the pressures on the areas. The system is developed to be used in Natura 2000 areas further developed to include the generally protected nature types in Denmark. Indicators for structural elements and species composition are used to calculate a structural index and a species index. The structural elements are simple to observe visually and hold important information on the present biological condition of the habitat types. The species composition is an important source of information in the identification of the habitat types and the characterisation of the biological quality. The species composition is registered in a circle of 5-m radius, with its centre in a homogeneous area characteristic of the habitat type.

The field collection of data from an area can be made within 1 to 2 hours. The biological quality index is characterised on a reference scale from 0 to 1, where 1 is the optimal condition. Based on this index the areas can be categorised in five biological condition classes analogous to the ecological condition classes used in the EU Water Frame Directive ranging from poor to high conditions.

A total inventory of the Danish NATURA 2000 designated areas has been carried out in 2004-5. In the presentation a short overview of these results will be given.

Land system science: Crossing the boundaries between the natural and social sciences

By Kjeld Rasmussen

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Abstract
Any study of Man-Environment (M-E) interactions transgresses, explicitly or implicitly, well-established boundaries between natural and social sciences. This is also true in 'land system science', no matter how it is defined. This paper will examine what this involves, mostly in a 'science studies perspective'. This perspective combines 'theory of science' and 'sociology of science' view-points, asking questions such as:

- Is there a shared and unified 'general science', and if so what is it characteristics? Is it an ontological, epistemological or methodological unification?
- Do coupled bio-physical and 'human' systems have emergent properties?
- Are there distinct differences in the types of explanations used in natural and social science, and if so does these cause problems in M-E research?
- Are social sciences dominated by normative and natural sciences by non-normative statements or basic assumptions?
- Does the use of mathematical models, GIS and mathematical and statistical methods imply reductionism?
- Can and do social and natural scientists agree on what is 'good science'?

The discussion of these questions is taken as a point of departure for a critical analysis of the science plan of the 'Global Land Project'.

Land systems science and history

By Lowe Börjeson

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Abstract
History, or historical perspectives, is generally regarded by the emerging land systems science community to be of importance. However, this is an endeavour that also implies epistemological challenges. What are the practical and theoretical limitations and opportunities for land systems science to engage with a genuine historical perspective? In this presentation I will address the scientific agenda of land systems science on the basis of my experience of landscape history research, in East Africa, in an interdisciplinary context.

Thinking outside the box … – 10 years of practical experiences in interdisciplinary education and research

By Jakob Magid, Andreas de Neergaard and Peter Oksen

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Abstract
The Danish University Consortium for Sustainable Land Use and Natural Resource Management (SLUSE) was established in 1996, with the aim to facilitate development of the human resource base in participating universities both in Denmark and the recipient southern countries. The focus was upon enhancing capacity mainly in education and to a lesser extent research on an interdisciplinary basis, in the areas of development and environmental and natural resource management. The establishment of university consortia was initiated and funded both in Denmark and in countries receiving Danish assistance. As a consequence, consortia were established in Malaysia, Thailand and southern Africa. The total number of students who have registered for SLUSE is well over 1000.

A tracer study has been carried out in order to take stock of the footprint of these activities. The original key characteristics and ethos of SLUSE such as interdisciplinarity, problem-orientation, interculturality and internationality have been honoured, maintained and developed throughout. The constant challenge has been to maintain sufficient 'depth' and at the same time ensure sufficient interdisciplinarity. Student assessments as well as the high regard employers have for SLUSE graduates interdisciplinarity and problem-based analytical skills, suggests that SLUSE has found the right balance on the educational side.

Although more than 130 papers have been written that relate to the SLUSE effort the outcome is less clear with regard to the research carried out. Due to changing donor priorities a fully fledged research component was never initiated, and therefore the partner universities were not funded for research, and the funding set aside for Danish universities was relatively sparse. Thus coordinated research efforts were not written into the work programs. Therefore much of the research has been carried out by individual PhD students, and part of it in short 'con amore' bursts by larger very interdisciplinary teams. Never the less a number of issues have emerged that may have a general bearing on interdisciplinary research in land systems.

Working in an interdisciplinary setting is often confusing, while stimulating, because it challenges the disciplinary approach, and sometimes forces the researchers to

give up their own perspective, realizing that it does not capture the essence of the problems at hand. We have found that joint fieldwork in longer periods is needed in order to develop a common understanding and bridge conceptual gaps. The merits of interdisciplinary research are currently not well recognized, and it has occasionally proven hard to find respectable outlets for research that is based on both natural and social sciences – because the reviewers are not comfortable with this work, or fail to recognize methodologies from other disciplines as scientifically valid.

The interdisciplinary research in Land Use related has been effective in posing questions to and challenging mainstream paradigms, but translating this understanding into scientific journals requires more footwork and much more exhaustive documentation, compared to publishing papers that are in line with common thinking.

Novel approaches to long-term reconstruction of past landscapes and land use as an aid to present and future landscape management

By Marie-José Gaillard

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Abstract
Reconstruction of past vegetation and landscape using fossil pollen has long been hampered by a lack of theoretically-sound methods. The theoretical basis and applications of the Landscape Reconstruction Algorithm (LRA), a two-step framework of quantitative reconstruction of vegetation and landscape based on the up-to-dated theory of pollen analysis (Sugita 2007a,b) will be described briefly. LRA first uses the REVEALS (Regional Estimates of VEgetation Abundance from Large Sites) model (Sugita 1007a) to estimate regional vegetation using pollen from multiple sites ≥1-5 □ 102 ha.

Background pollen coming from beyond the relevant source area of pollen (Sugita 1994) is expected to change through time, because changes in natural and anthropogenic factors affect regional vegetation. Given the regional vegetation, the second step of LRA uses the LOVE (LOcal Vegetation Estimates) model (Sugita 2007b) to calculate background pollen and incorporate it into reconstruction of vegetation composition within the relevant source area for smaller sites <102 ha. Simulations (Sugita 2007b) show that LOVE can provide accurate results by correcting for both the non-linear nature of the relationships between pollen percentages and vegetation abundance and the differences in background pollen. LRA has been tested using modern training data sets from two regions (Skåne and Småland) in southern Sweden. The relative abundance of the modern regional vegetation predicted by REVEALS matches well to that actually calculated and compiled from vegetation inventory data, satellite and aerial photos, and crop statistics (Hellman et al. 2007). LOVE provides the accurate vegetation composition within the relevant source area of pollen for the moss-polster sites (Broström et al. 2005; Sugita et al. in prep.).

Reconstructed landscapes in southern Sweden during the Holocene suggest that human impacts on land cover were more profound than changes in pollen percentages would suggest. Anthropogenic impacts on land use and land cover would have had larger effects on regional climate and ecosystems in northern Europe than the changes previously indicated by pollen percentage data alone (Anderson et al. 2006). Applications of the novel approaches to landscape management will be discussed on the basis of a few examples from southern Sweden.

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Effective Governance for Sustainability - Landscape Character Assessment at the Municipality level in Denmark

By Ole Hjorth Caspersen

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Abstract
In 2007 a new planning reform reduced the number of municipalities in Denmark from 298 to 98. The reform also transferred landscape planning and management from county to municipality level. Hence the new municipalities have to adopt new methods and skills in order to comply with the new tasks. This presentation discusses how the Landscape Character Assessment (LCA) method can support the municipalities in order to conduct effective governance for sustainability. However specifically it focuses on the assessment of amenity values and esthetical aspects and the problems that relate to the assessment of detailed ecological aspects that relate to landscape.

LCA was implemented in the Planning Policy Guidance in UK during 1997 as a tool in planning for sustainable development and LCA is an aid to decision making. The LCA guidance defines it as a tool to help to understand what the landscape is like today and its role is to ensure that change and development does not undermine whatever is characteristic or valued about any particular landscape.

Since 2003 of group of Danish planners and researchers has adapted the method to Danish conditions. In the Danish version the method is divided into 7 steps. These steps includes both desk and field studies. The field survey is important in order to identify key elements and features that are not apparent from the desk study. Aesthetical and perceptual qualities that are not perceived from the map analysis complement the desk study.

Description, analysis and mapping are important elements in LCA. The method is based on GIS and digital maps and the field study uses digital registration by use of GIS combined with digital field survey sheets. By that the method becomes an important element in the forthcoming digital municipality plans.

What the Bird's Eye View Does and Does Not Reveal about Land Systems

By Ruth DeFries

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Abstract
Land systems science relies on remote sensing to detect and monitor land cover changes. Yet mismatches remain between data sets derived from remotely sensed data and analyses of land systems. Multiple factors contribute to this mismatch: lack of analytical tools to assess how changes in land use alter human livelihoods and well-being; varying scales required for different analyses of land systems; and conceptual difficulties in defining key attributes for land systems science. Consideration of the appropriate scales and attributes required for different land systems --with particular attention to the links with livelihoods, well-being, and ecosystem services—is a challenge for land systems science.

Functional approaches to quantifying the response to land use change of multiple ecosystem service delivery

By Sandra Lavorel

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Abstract
Methods for assessment of changes in ecosystem service delivery in response to land use change have been developed recently to account for gains or losses in different sets of values (economic, social, etc.), and resulting changes in human well-being. At the same time ecological studies have quantified effects of land use on some ecosystem properties that contribute to different ecosystem services, but this has been done without links to stakeholder representations of what constitutes a service (or disservice), and which ecological features contribute to its delivery.

Further, there is a need for generalisation on relationships between ecosystem components (organisms and processes) and ecosystem services in order to assess vulnerability to global change across regions. Here we present a semi-quantitative framework that aims to address this need, and illustrate it with results from studies on subalpine grasslands and other European traditional landscapes ongoing rapid change in agriculture. This example is used to demonstrate how in depth ecological knowledge of functional relationships between plant characteristics and ecosystem properties can be extended to quantify and project ecosystem services. Functional approaches make it possible to build dynamic models of ecosystem service delivery. The next challenge lies in coupling these models with dynamic models of land use.

Advances in Land Models

By Tom Veldkamp

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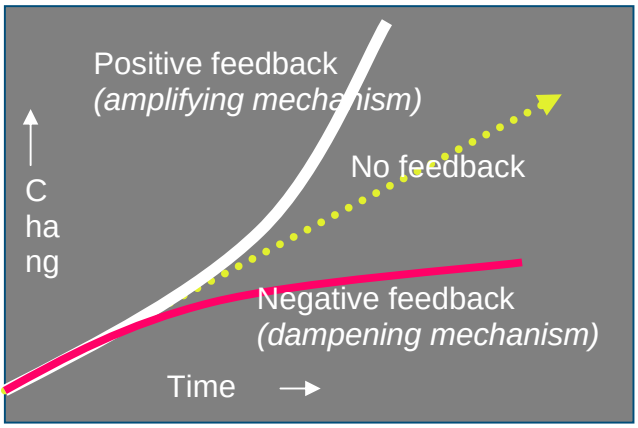
Abstract
Land change is influenced by many interacting processes involving both the bio-physical environment and human decision making. The resulting land changes may in turn affect the environmental properties of a landscape and/or the living conditions of people. These interactions of processes are often referred to as feedback mechanisms. One way of studying these interactions in a controlled environment is by means of modelling.

After giving an overview of current developments and challenges in land science modelling, the focus of this presentation will be on the concepts of dynamic modelling of feedback mechanisms between land use change and geomorphic processes. The functioning of different types of feedbacks (bio-physical constraints and human decision making) will be discussed. As a first case study an initial application combines well established land use change model and a landscape process model. Initial results demonstrate the many uncertainties involved. Preliminary conclusion is that we need to develop techniques to separate the different sources of uncertainties in these models in order to gain meaningful insights.



Land change and infectious diseases: the emerging discipline of spatial epidemiology

By Eric Lambin

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Abstract
Spatial epidemiology is the study of spatial variation in disease risk or incidence. Land change may have significant consequences for human health through emerging zoonotic and vector-borne diseases. Land-cover change may influence the habitat, and therefore the distribution and abundance, of vectors. Land use mediates human-vector interactions, including biting rate. We developed a conceptual model representing interactions between people (as agents of land-use change and disease hosts), the landscape (as being used by people for their livelihood as well as providing habitats for mosquitoes), and mosquitoes (as disease vectors). After extensive data collection and analysis, we integrated knowledge linking land use to disease via vector abundance. This research operates across multiple disciplines, scales of analysis, data collection methods, and modeling designs. Examples of mosquito-borne diseases (malaria and dengue), tick-borne diseases (Lyme disease and tick-borne encephalitis), and zoonotic diseases (hantavirus) will be presented. Spatially-explicit multi-agent simulations allow integration of data and knowledge from the multiple disciplines contributing to spatial epidemiology.

Farm Nitrogen balances in European landscapes - methods for modeling and scaling

By Dalgaard T[1], Cellier P[2], Dragosits U[3], Drouet JL[4], Happe K[5], Hutchings N[6], Olesen JE[7], Theobald M[8]

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Abstract
The aim of this study is to present methods to model farm Nitrogen (N) balances and N flows in European landscapes. The critical factors to include in the models are reviewed, and examples of the modeling of farm N balances in a number of European landscapes are shown. The results draw on experiences from the EU funded research projects NitroEurope (www.NitroEurope.eu), MEA-scope (www.MEA-scope.org) and SENSOR (www.SENSOR-ip.org), and from national Danish and British research projects outlined in the publications from the previous international Nitrogen conferences.

In particular, we focus on the use of the dynamic whole farm model FASSET (www.FASSET.dk), and the Farm-N tool (www.farm-N.dk/FarmNTool) to calculate yearly Farm-N balances, and distribute the surplus N into different types of N-losses (evaporation, denitrification, leaching). In MEA-scope these two models are linked to economic modelling, whereby effects of farm structural developments induced by policy changes can be assessed. In NitroEurope the farm models will be linked to other ecosystems models as well as atmospheric and hydrological N-flow models, thereby enabling modelling of the whole N cascade and the overall Nitrogen balance for whole watersheds or landscapes.

The importance of handling spatio-temporal dynamics and the effect of structural changes are outlined with results from the above projects, and the problems of integrating information from different scales in the modeling of landscape level farm Nitrogen balances are discussed. It is concluded, that landscape level modeling of farm N balances and N flows is an important and often neglected discipline, which allows upscaling of farm N-balances and N-emissions results from plot/field/farm level to regional/national or international levels.

Modelling of climate and land-use changes on nitrate leaching and water balance

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Abstract
Future changes in temperature and precipitation caused by increase of greenhouse gasses in the atmosphere will influence water balance of the root zone and will probably also cause land-use changes in form of change in crop rotation in Danish agriculture. The area with maize and the dry matter production of maize per hectare has increased in Denmark during the last 10-15 years. In the same period the temperature in the growing season also has raised, so a probably adoption to a future warmer climate in Denmark could be a continuing increase of the maize area. In studies on nitrate leaching on RUC's experimental field in the period 2000-2004 the Daisy model have been used. This set up of the Daisy model have been used in this study on modelling the effect of estimated climate change in 2071-2100 on water balance and nitrate leaching. The modelling was done with the actual crop rotation (scenario 1) and with a crop rotation including maize (scenario 2) and the results were compared to the situation 1995-2004 (control). The results of the modelling of scenario 1 show that the change of climate increased the nitrate leaching with 22% and percolation with 17%. By having one year with maize instead of winter wheat in the five year crop rotation (scenario 2) gave rise to a further increase of nitrate-leaching by 4 percent points but due to higher transpiration from maize compared to winter wheat the percolation decreased by 2 percent points. It is also clear that these changes depend on soil conditions both in absolute values and in percent and with the coarsest textured soil giving the highest change.

Acknowledgement: This study was conducted in relation to the research project "Remote sensing of leaf nutrition and its incorporation for biochemical and environmental modeling of crop photosynthesis and evapotranspiration" (2005-2007).

Quantitative reconstruction of past Danish landscapes: The first results

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Abstract
We present a first attempt at pollen based quantitative reconstruction of land cover around 9 Danish lake sites for the past 2500 years, based on models of pollen dispersal and -deposition (Prentice, 1985; Sugita, 1993, 1994), and pollen productivity estimates produced from a historical calibration dataset of AD 1800 pollen assemblages and historical plant abundance (Nielsen, 2004; Nielsen & Odgaard, 2005).

A new model, REVEALS (Sugita, in press), is used to reconstruct past regional abundance of the plant groups trees, grasses, cereals and heather, in 500 year intervals. These estimates are then used in the Landscape Reconstruction Algorithm, LRA, (Sugita & Walker, 2000; Sugita, in press) to separate background and local pollen signals at small sites, thus providing reconstructions of local vegetation around the sites.

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Event driven adaptation, land use and human coping strategies - human-environment interaction in a smaller SWP island society

By Anette Reenberg (ar), Torben Birch-Thomsen (tbt), Bjarne Fog (bf)

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Abstract
The paper focuses on assessing the wider perspectives of adaptive resource management strategies in former subsistence agriculture societies in the SW Pacific. Firstly, we will briefly introduce the theoretical context related to the livelihood framework, adaptation to socio-environmental change and the concept of coupled human-environmental timelines. Secondly, with point of departure in a baseline characterization of Bellona Island derived from a comprehensive survey in the late 1960s and resent fieldwork in late 2006, we present the case of Bellona Island. Key issues addressed concern climatic events, population, agricultural strategies, land use, livelihood strategies, non-agricultural activities, etc. Satellite imagery and aerial photos show relative stability in agricultural land despite an increase in de facto population (51% from 1966-2006). A questionnaire survey of 48 households provide data on the entire household livelihood portfolio and reveal that the natural resources remains a widespread activity, yet increasingly supplemented by other income generating activities(ex. shop keeping, private business, government employment). Group interviews have been employed to reveal how local farmers perceive cause-effect relationships between societal and environmental events and their individual and collective management of resources. The coupled human-environment timelines are used to discuss ways in which the local communities' adaptive resource management strategies have been employed in the face of main drivers of change, incl. climatic and socio-economic changes in the recent past.

Keywords: Human-environment timelines, adaptation, land use, livelihood, SW Pacific, Solomon Islands

Farming system changes among ethnic minorities in the Vietnamese uplands – A comparative village-study on the effects of land allocation in terms of food security, livelihoods & land use changes

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Abstract
While rural poverty is rapidly being reduced in Vietnam and food security is no longer considered a major issue at the national level, these remain persistent problems among the ethnic minorities living in the Vietnamese uplands. Poverty, food insecurity, rapid population growth and forest degradation have led scholars to describe the situation in the Vietnamese uplands as a "deepening environmental and social crisis" (Jamieson et al., 1998, pp 3; Cuc & Rambo, 2001). The Vietnamese government – supported by international donors – has envisaged an agrarian transition towards market-oriented production as the appropriate, sustainable development pathway for the ethnic minorities in the uplands. The ethnic minorities residing the uplands are mainly shifting cultivators and the government has implemented a land allocation programme transferring land use rights to households as a mean to protect the forests from shifting cultivation, coupled by the expansion of paddy rice cultivation to compensate for the loss of land. Research conducted between 2003-2005 in the North Central uplands (Nghe An Province) explored the outcome of the Vietnamese government's land allocation programme and associated land use policies on land use, farming systems and livelihoods of different ethnic minority groups. Findings indicate that the envisaged agrarian transition has so far had limited impact on the livelihoods of the ethnic minorities. Subsistence production remained crucial for maintaining food security for the ethnic minorities under investigation and subsistence production continued to derive mainly from upland rice cultivation and less so from the cultivation of paddy rice. The combined effects of the land allocation policies, forest protection policies, population growth, and in migration, resulted in a shift from long fallow shifting cultivation on the steep hillsides to short fallow rotation with increasingly long cultivation periods. Farmers had generally not undertaken land investments on their allocated upland fields but had responded to restrictions on land availability by a combination of 1) diversifying their livelihoods (primarily into animal husbandry), 2) undertaking informal land transactions in order to uphold land availability, 3) disobeying the land allocation policies, and 4) continuing to obey traditional community-based tenure regulations. Findings showed that cash income did not play a great role in assuring food security and that farmers were not undertaking a fully market oriented strategy – giving up the subsistence production in order to maximize cash incomes.

Agricultural change and soil degradation on Bellona, Solomon Islands

By Sabrina Rothausen

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Abstract
A rising degree of globalization is changing structures and processes in society which affects the way of living - especially in developing countries. Subsistence farming is originally one of the most important activities on Bellona, but with changing livelihood strategies, agriculture is given another role. Changes in farming systems are often having a detrimental effect on the natural resources through e.g. soil degradation. The inhabitants on Bellona are complaining about decreasing soil fertility and a rising degree of pests and hazards. Whether resource depletion really is taking place can be questioned, as can the driving forces behind these processes. Field work was carried out on Bellona, Solomon Islands in November/December 2006 as part of the interdisciplinary CLIP-project dealing with climate, livelihoods and production in the South Pacific. This poster will introduce the progressing work on a master thesis dealing with agricultural system changes and the possible effects on natural resources with focus on soil quality. The changes in soil quality and nutrient level will be evaluated through soil sample analysis, a fertilizer experiment and a comparison of soil samples from 1967. Likewise, changes in crops, rotation systems and agricultural practices will be considered. So far results have shown no remarkable soil degradation and limited change in the area of cultivated land, but changes in soil quality throughout the last 40 years under specified land use types are yet to be analyzed. Furthermore, it is important to understand the human dimension of land use changes to evaluate the sustainability of the farming systems on Bellona. When assessing the consequences of soil degradation it is therefore necessary to consider the complexity and interaction of socio-economic parameters affecting the livelihood systems.

Self sufficiency of isolated land use systems: The case of Tikopia

By Thilde Bech Bruun (tbb), Ole Mertz (om) and Bjarne Fog (bf)

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Abstract
This study examines the land use system of Tikopia – an isolated Polynesian island located in the far east of the Solomon Island (12.5°S and 170.5°E). Tikopia has an area of merely 4.6 km2 and consists of an extinct volcano with a harsh topography but very fertile soils. Tikopia sustains a population of about 1200 persons and has done so for centuries. As the physical contact between Tikopia and the rest of the world is restricted to a couple of irregular freighter ships per year, the island can be considered a fairly closed system in terms of exchange with the outside world. With respect to food production the island is completely self sufficient.

Almost the entire island is under permanent cultivation with no use of external inputs of any kind. The Tikopians practice an intensive agroforestry system in which different types of taro are intercropped with perennials such as bananas, sago palms, bread fruit trees and coconut palms in forest gardens. Fallows are only used to a very limited extend for taro and cassava cultivation and managed in a slash-and-mulch system without burning.

The different aspects of the current land use system were analysed to determine how the system has developed since it was described by other studies in the 1920s and 1970s. The study was undertaken by an interdisciplinary team of researchers applying a range of methods from different scientific fields including classification of satellite images, questionnaire surveys, detailed household interviews, focus group interviews, field measurements and soil sampling.

The land use system of Tikopia was found to have remained unchanged and to be very well adapted to the environmental conditions and to the isolation of the island. There are no signs of degradation of the natural resource base caused by the land use system and no indications that Tikopia should not be able to feed itself in the future. The land use system was found highly resilient towards shocks such as extreme climate events.

Climate change impacts on Pacific atolls: Vulnerability and adaptive capacity - A case study from Ontong Java atoll, Solomon Islands

By Thomas Birk

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Abstract
Small islands in the tropics are expected to be critically affected by climate change impacts in the near future. On low-lying atolls, the latest IPCC-projected scenarios of sea-level rise in the order of 20-60 cm by the end of the century will increase already existing problems of erosion, flooding, and salt water contamination of groundwater and crop land. In addition, the increase of sea surface temperatures (SST) and change of ocean carbon chemistry towards lower pH is expected to jeopardize the future existence of coral reefs. Already the livelihoods of many small island and atoll communities are considered vulnerable to external socio-economic pressures. Facing future climate change impacts, and in lack of government support and assistance from foreign benefactors, these communities could be pushed towards the edge of collapse.

A field work study on Ontong Java atoll was carried out as part of the CLIP1 project, which is attached to the Galathea 3 Research Expedition. Findings from the study demonstrates how communities on the islands Luaniua and Pelau have coped with extreme weather events in the past, but also reveal an emergent need to strengthen adaptive capacity and resilience towards future climate change impacts on these particular islands.

[1] CLIP: Sustainable resource use or imminent collapse? Climate, livelihoods and production in the Southwest Pacific (CLIP)

Exploratory statistics and neural networks to model post-socialist cropland abandonment in Romania

By Tobia Lakes, Daniel Müller, Tobias Kümmerle and Patrick Hostert

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Abstract
Cropland abandonment happened at unprecedented rates in most countries of Central and Eastern Europe and the Commonwealth of Independent States. This process resembles an example of land use change which requires an interdisciplinary approach to study human-environmental interrelationships and processes. Although considerable progress has been achieved in theory and concepts of LUCC, empirical approaches are mandatory to study the various interacting factors which influence LUCC, such as governance, economy, management, and the environmental boundary conditions.

This research investigates cropland abandonment in the Romanian foothills of the Carpathians. Land-change patterns are derived by digital change detection from multi-seasonal Landsat images in five-year time steps from 1990 to 2005. Driving factors include biophysical variables that are integrated with socioeconomic and political indicators from primary census data. Underlying factors that led to cropland abandonment are estimated by spatially explicit logit regressions that combine land-cover data with hypothesized biophysical, socioeconomic, and political driving forces. Cropland abandonment since the collapse of socialism mirrored distinct temporal and spatial variation and significantly changed Romanian rural landscapes. Significant predictors were fed into an artificial neural network model (the Land Transformation Model, LTM) that served to predict the likely spatial arrangement of future cropland abandonment. The LTM was calibrated for the decrease in cropland between 1995 and 2005, a period when cropland abandonment remained considerable, but did not include the immediate reactions of land users to the Romanian land reform. Forecasts for a range of hypothesized future abandonment rates resulted in maps depicting the likelihood of future abandonment. Both modeling approaches have their strengths and weaknesses, and complement each other.

The spatial logit model focuses on exogenous, underlying variables that foster land change and is valuable to rank the importance of factors and to test hypotheses. Artificial neural networks provide a data-driven tool allowing to derive new insights from empirical data, e.g., into the spatial patterns of change given a certain magnitude of change. These new findings are of particular importance to

understand processes in postsocialist countries, where empirical evidence on the local driving factors and possible future developments is scarce. The proposed combination of modeling approaches may further assist to develop more rigorous scenarios and can offer new insights to support decision-making, land management politics, and planning.

Transboundary assessments of post-socialist land use change in the Carpathians. How important are different land reforms and ownership patterns?

By Tobias Kümmerle, Patrick Hostert, Tobia Lakes and Daniel Müller

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Abstract

Broad-scale political and socio-economic conditions are powerful determinants of land use change; yet, their relative importance remains often unclear. The transition from command economies towards free-market systems in Eastern Europe after 1989 offers unique opportunities to better understand how changes in such broad-scale determinants affect land use decisions. We studied post-socialist land use change in the border triangle of Poland, Slovakia, and Ukraine in the Carpathians, because cross-border comparisons allow for decoupling overall trends in the transition period from country specific changes. Post-socialist land use change was quantified based on Landsat TM/ETM+ images by (1) comparing contemporary (year 2000) landscapes among countries, and (2) using images from 1986 to 2000 to investigate whether differences originated from socialist or post-socialist land use change. Results indicated that forest change, farmland abandonment, and farmland parcelization were widespread in the transition period, likely due to worsening economic conditions, weakened institutions, and societal change.

However, land use trends also differed strongly among the three countries due to dissimilar land ownership patterns, land management practices, and land reforms. Poland and Slovakia converged in the transition period in terms of land cover, while Ukraine clearly diverged. In our case, broad-scale land use determinants were of paramount importance to understand post-socialist land use change and we suggest they may be equally important in regions where such factors change gradually, too.

Linking forest and livelihood changes in rural Armenia

By Daniel Müller[1], Franziska Schaft[1], Hovik Sayadyan[2], Rafael Moreno-Sanchez[3]

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Abstract
Armenia harbors forest resources of high nature conservation value. As in other parts of the Caucasus, Armenia's forests are extremely rich in biodiversity and home to many endemic and red-book listed species. Forests play an important environmental role in the protection from land degradation, and resilience against floods and land slides. Forests also provide important services and products to Armenia's rural population, including the provision of income, energy, medicinal and edible plants, and recreation. Sustainable forestry is therefore of paramount importance and has been declared a priority by the Armenian government to achieve the national Millennium Development Goals. However, to date there are no realistic estimates of the extent and quality of Armenia's forests and an effective forest inventory and monitoring system is missing. Field inventories of 1988-1989 suggest a forest cover at the country level of 11% that already decreased to around 8% at present. Illegal logging is widespread and ongoing, both for industrial purposes and to support rural livelihoods.

The proposed project attempts to disentangle the connections between rural livelihoods and forest resources. To do this, we will combine qualitative with quantitative techniques to deal with socioeconomic and geographic data. Our approach includes four stages: First, we will quantify the amount and the spatial pattern of forest-cover change in the last 25 years in the Southern foothills of the Caucasian mountain range with a combination of high- and medium resolution satellite images and state-of-the-art digital change detection. Second, Bayesian belief networks will combine qualitative and quantitative data to model key factors affecting livelihoods. The Bayesian network will aim to identify and analyze forest resource beneficiaries and assess the importance of forest goods and services for rural households for a small number of villages, accompanied by participatory resource mapping. Third, we will conduct a regional survey covering key economic and social indicators that were identified in the network analysis. Survey data will be integrated with spatially explicit data to explore key exogenous characteristics and influences of forest-cover change by means of spatial statistics. Last, we will simulate future scenarios of forest-cover change by calibrating neural network

models under various change scenarios identified in the socioeconomic work packages. In that way, we will be able to identify hotspots of future deforestation.

Our results will be an important contribution towards effective monitoring, planning, and sustainable management of Armenia's remaining forest resources. Moreover, our project will be one of the first projects in the Caucasian region and thus help to close the regional gap of land-change science in the Caucasus. Project scientists comprise of partners from multiple countries (Armenia, the US, Australia, and Germany) and various disciplines (economics, geography, forestry, agriculture, and ecology). The tight integration of Armenian scientists will be crucial to build a functioning network, exchange and improve knowledge in research and higher education, and to ensure better outreach of the findings.

Curbing Environmental Degradation: Agro forestry Management Practice for Arable Land in the Benue valley of Nigeria

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Abstract
Agriculture is the main stay of the Nigerian economy. The mode of production is subsistence in orientation and constitutes a serious threat to environmental sustainability and productivity. This system entails the clearing of forest and savanna woodland (slash and burn) annually and therefore subjecting a specific area to intense continuous cultivation. Consequently, the soil become very fragile and loose with low Nitrogen and organic matter content. In addition, the study area is experiencing an increasing population pressure that has resulted in declining fallow periods. Forest cover ensures proper protection and stabilization of soils. The cropping activities of the peasant farmers destroy these forest covers and the much cherished arable land is being predisposed to rapid degradation. This study examines the efficacy of some agro-forestry practices amongst the peasant's farmers in their attempt to cope with declining soil fertility. The study found scattered tree farm system, border tree planting and alley cropping system to be beneficial to the farmers. The farming systems and the attendant advantages of soil fertility improvement, provision of fuel wood, poles, timber, fodder and contribution to environmental sustainability were adequately discussed in the study.